

The Placid HD V2.1 Guide Revision 1.0

By Leon van Bommel

Table of Contents

About this manual	3
Lay-out of Placid HD BP 2.1	4
Overview	5
Building the modules.....	7
Connecting the transformers.....	9
First use of the modules.....	10
Appendix: Parts list Placid HD 2.1	11
Appendix: Parts list Placid HD BP 2.1	12
Appendix: References.....	13

About this manual

This manual provides an update for the official Placid manuals. This is by no means a replacement for the official manuals: the modules features and specifications are subject to constant improvement. See <http://www.twistedpearaudio.com/docs/docs.aspx> for the latest versions of the official and community manuals.

Notice: for DIY only

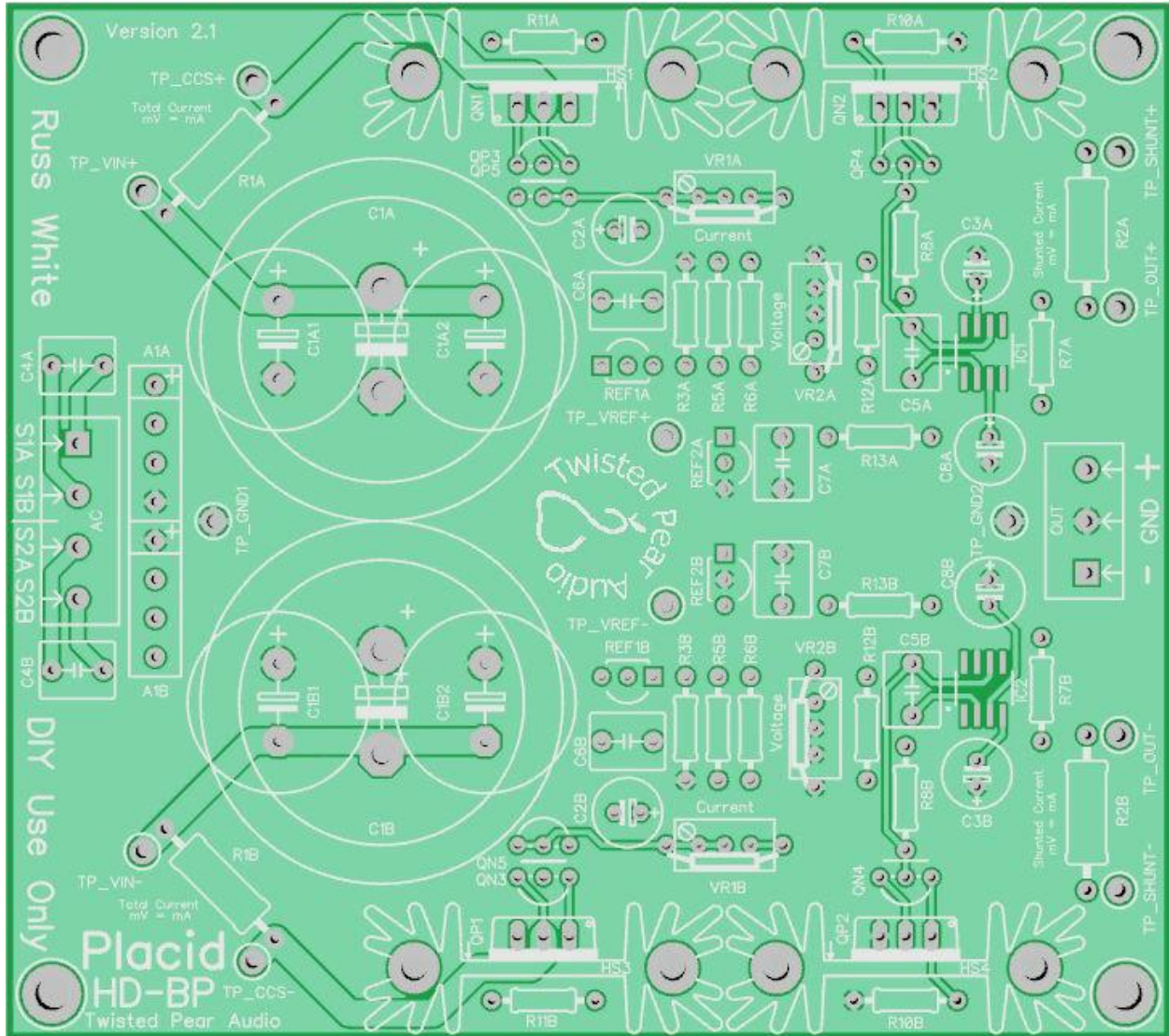
These modules are designed by Russ White from Twisted Pear Audio. The modules are meant for DIY use only, as clearly stated on the PCB. They are not meant for commercial use.

The fact that Twisted Pear Audio produces these boards for DIY use and provides you with full documentation including a schematic does not mean the design is open source or meant to be copied. The purpose of the schematic is to provide users with information they need to locate and troubleshoot problems.

Naming of the Placid HD board

In the text the name Placid-series or Placid HD/HD BP means either the Placid HD 2.1 power supply board or the Placid HD BP 2.1 power supply board, indicating things apply to or work with both boards. If the text only mentions the Placid HD or the Placid HD BP, that part only applies to that particular version of the power supply.

Lay-out of Placid HD BP 2.1



Overview

The Placid HD-series power supplies are shunt regulated DC power supplies for low noise and excellent line and load regulation. The new 2.1 version is built around Linear Technology LT1034 precision voltage references, providing less variance than the LEDs of earlier versions. This makes it easier to set the output voltage with a resistor.

Shunt module

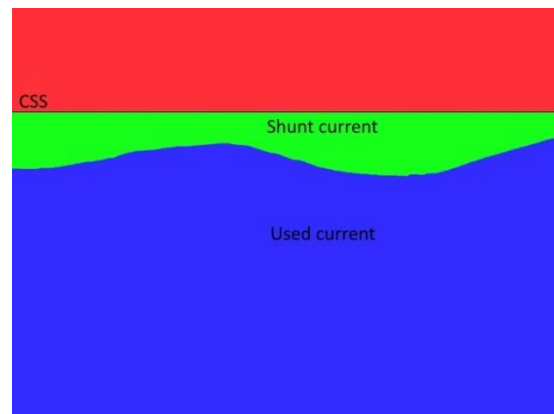
The Placid series of power supplies are shunt regulators. This means the power supply delivers more power, referred to as constant current source (CCS) than is required at any time. The excess power supplied is shunted (shunt current) and transformed into heat.

$$CCS\ current = average\ current\ for\ module(s)\ being\ powered + shunt\ current$$

The diagram shows this behaviour: you set the CSS point (the black line). This is a constant current which the power supply provides to the circuit. Not all of it is used: the green part of the diagram is converted into heat. As displayed, the amount of power that is used can vary (blue).

As one might understand this is not the most efficient use of power, but it does offer a very clear advantage: the output of shunt regulators usually has extremely low amounts of noise. This makes it a favorite choice for audio applications.

From a DIY perspective, shunt regulators are safer to use than many other types of regulators. If a shunt regulator runs out of current (i.e. blue gets above the black line, into the red zone), it's output voltage will drop at an incredible rate. In most cases this behaviour acts as a decent over-current protection. So if the circuit you are powering develops a short, it's unlikely there will be a lot of damage to the PSU and the rest of your project.



Versions

The Placid HD is available in 2 versions:

Module	Type	Recommended transformer	Main use
Placid HD	Normal	9V (15VA)	5 or 5.25V PSU for various modules
Placid HD BP	Bi-polar	15V+15V (50VA)	12 or 15V PSU for I/V stages

The Placid HD BP is a bi-polar power supply, meaning it supplies 3 voltages, for example: -15V, 0V and 15V. The Placid HD BP needs to be fed using a dual secondary transformer.

The Placid HD is basically just the positive half of a Placid HD BP.

This manual assumes you are using the PSUs for one of the above purposes, using Twisted Pear Audio's transformers to power the Placid HD-series power supplies.

In the package

Both of these PSUs are available as a kit and as a PCB. When ordering the PCB, you'll receive just the bare PCB (right in picture), but when ordering the kit you'll get the PCB with the SMD parts already installed, all of the parts required to build the PSU plus everything needed to integrate the PSU into your project:

- Connector blocks for AC, output
- Heatsinks (including mounting screws, nuts and thermal paste)
- Stand-offs of sufficient height plus screws to mount the module in your case

Note: contents of the packages are subject to change without further notice.



One of the big advantages of the Placid HD 2.1 kits is that they come with one of the largest heatsinks that fit on the board: the Wakefield 637-25ABP. These normally can't be ordered in small quantities, so order the kit if you think you'll need to supply a lot of current and are unable to use the chassis as a heatsink.

Building the modules

Populate the circuit board as you normally would; mount components from shortest to tallest. Each part in the kit is labeled with a part number that matches the part number on the circuit board.

For the Placid HD BP, the two sides of the supply are virtual mirror images. Two sets of parts are supplied with the kit, one for each half of the PCB. Each part (except for transistors) is labeled with A and B on the board (e.g. “R1A” and “R1B”).

Setting the output voltage

For maximum flexibility a variable resistor is included to set the output voltage. But it is recommended to set the output voltage using a fixed resistor. When using a fixed resistor to set the output voltage you would omit the variable resistor on VR2 and use the two outer pads for the fixed resistor.

The output voltage is easily calculated using the following formula:

$$V_{out} = V_{ref} \times \left(1 + \frac{R12}{VR2}\right)$$

With the voltage reference LT1034 being 2.5V and R12 being 2K Ω this leads to the following simplified formula for VR2:

$$VR2 = \frac{5000}{V_{out} - 2.5}$$

For some popular output voltages this leads to the following values:

Desired V_{out}	Calculated VR2	Best match	Actual V_{out}
5V	2000	2K Ω	5V
5.25V	1818	1.82K Ω	5.247V
12V	526	511 Ω	12.28V
15V	400	402 Ω	14.94V

As one can see the actual value for 12V is quite a bit off due to not having a close match in the normal resistor values. A solution could be to use a different value for R12 or simply use the supplied variable resistor.

When an output voltage of above 15V is desired, it is recommended to increase R12.

Mounting the op-amps

The OPA209 is an SMD part. If you buy the kit this part is already soldered in place. If you buy parts please double check the orientation using the dot on the chip and the board. Fix the part on the board using a little tape to prevent movement.

Note: This part should be soldered in place according to the instructions of the manufacturer. Parts should be delivered ready to solder (sealed) or one should bake the parts as per instructions.

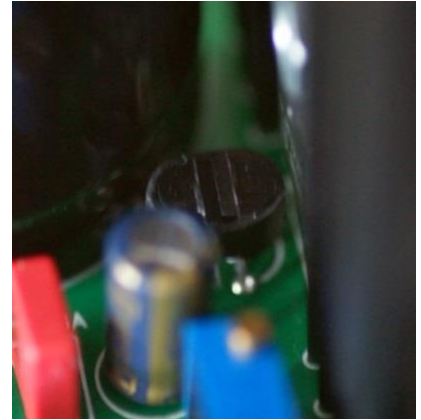


Mounting the transistors

Double check the parts prior to installation: are the parts of the correct type and oriented correctly? The paired small transistors QN3 and QN5 plus the pair QP3 and QP5 are meant to be thermo coupled. Join these before soldering them in place (see picture).

The larger TO-220 transistors should be attached to the heatsink prior to mounting them on the board. Apply a thin layer of thermal paste to the transistor before securing it on the heatsink.

Another option would be to mount the TO-220 parts to the chassis instead of using a heatsink. This is possible only when the chassis is a good thermal conductor like aluminium. There is no need for electric isolation, as the parts that Twisted Pear Audio provides are already isolated. Invert the parts that are normally attached to heatsinks so they are mounted below the board, and can be mounted to the chassis. Do this prior to soldering the parts to the board, so everything fits perfectly.



Connecting the transformers

A 9V transformer is connected to the 5.25V power supply.

A 15V transformer is connected to the 15V bipolar power supply. The colors used are described below:

Transformer	Load	Primary 1	Primary 2	Secondary 1	Secondary 2
9V	15VA	Blue, Grey	Violet, Brown	Black, Red	Orange, Yellow
15V	50VA	Blue, Grey	Violet, Brown	Black, Red	Orange, Yellow

Connecting the primary wires

For 115V use, connect the primary windings in parallel by connecting both Blue and Violet to the neutral wire and connecting both Grey and Brown to the hot wire.

For 230V use, connect the primary windings in series by connecting Grey to Violet, connect Blue to the neutral wire and connect Brown to the hot wire.

Connecting the secondary wires

When connecting the Placid HD, one could connect one of the secondary sets (Black, Red) to the power supply and use the second set (Orange, Yellow) to another power supply. Beware though that this does mean only half of the power (7.5VA) is available for the power supply, and the other half goes to the other power supply. Also there is no complete galvanic isolation between those two power supplies. The other option is to run parallel, fi. combine Black and Orange, and Red and Yellow to the respective inputs on the power supply.

When connecting the Placid HD BP, one should connect one of the secondary sets (Black, Red) to the negative half of the power supply and use the second set (Orange, Yellow) to connect to the positive half of the power supply.

First use of the modules

Safety

- The transformers have a high voltage AC side. These voltages are high enough to cause serious injuries or even death. Never work with blank wires on this side.
- Check your local safety regulations and make sure your build meets (at least) the minimum requirements.
- When using a metal chassis, work with double insulation on all wires carrying high voltage AC current or use single insulation plus maintain at least 10mm distance between the wire and the chassis. And just to be certain: ground the chassis.
- Use a fuse. This is easy to do when using a chassis power connector with integrated fuse holder.

Set up the modules

Before the first use, the modules need to be adjusted. Do not attach the transformer yet. If you are setting up the Placid BP remember to perform each step at each of the two sides.

1. Adjust VR1 (i.e. VR1A and VR1B for a Placid BP) so the resistance across it is around 500 Ω . This is a safe starting point.
2. If you are using the variable resistors for VR2, adjust VR2 to around 1K Ω .
3. Attach the transformer but do not attach the load yet.
4. Apply power
5. If required adjust the output voltage (VR2) as needed for your application.
6. Adjust VR1A and VR1B to set the CSS current.
7. Power off and connect the load.
8. Apply power
9. Check the output voltage and the shunt current. If the voltage is too low it's likely the CSS current is too low.
10. Adjust the CSS current so the shunt current is round 50-60mA.

Measuring CSS and shunt current

To measure CCS current measure the voltage between TP-VIN and TP-CCS. The measured voltage is the same as the current being sourced. Example: 250mV means 250mA is being sourced.

To measure the current being shunted measure the voltage between TP-OUT and TP-SHUNT. The measured voltage is the same as the current being sourced. Example: 50mV means 50mA is being shunted.

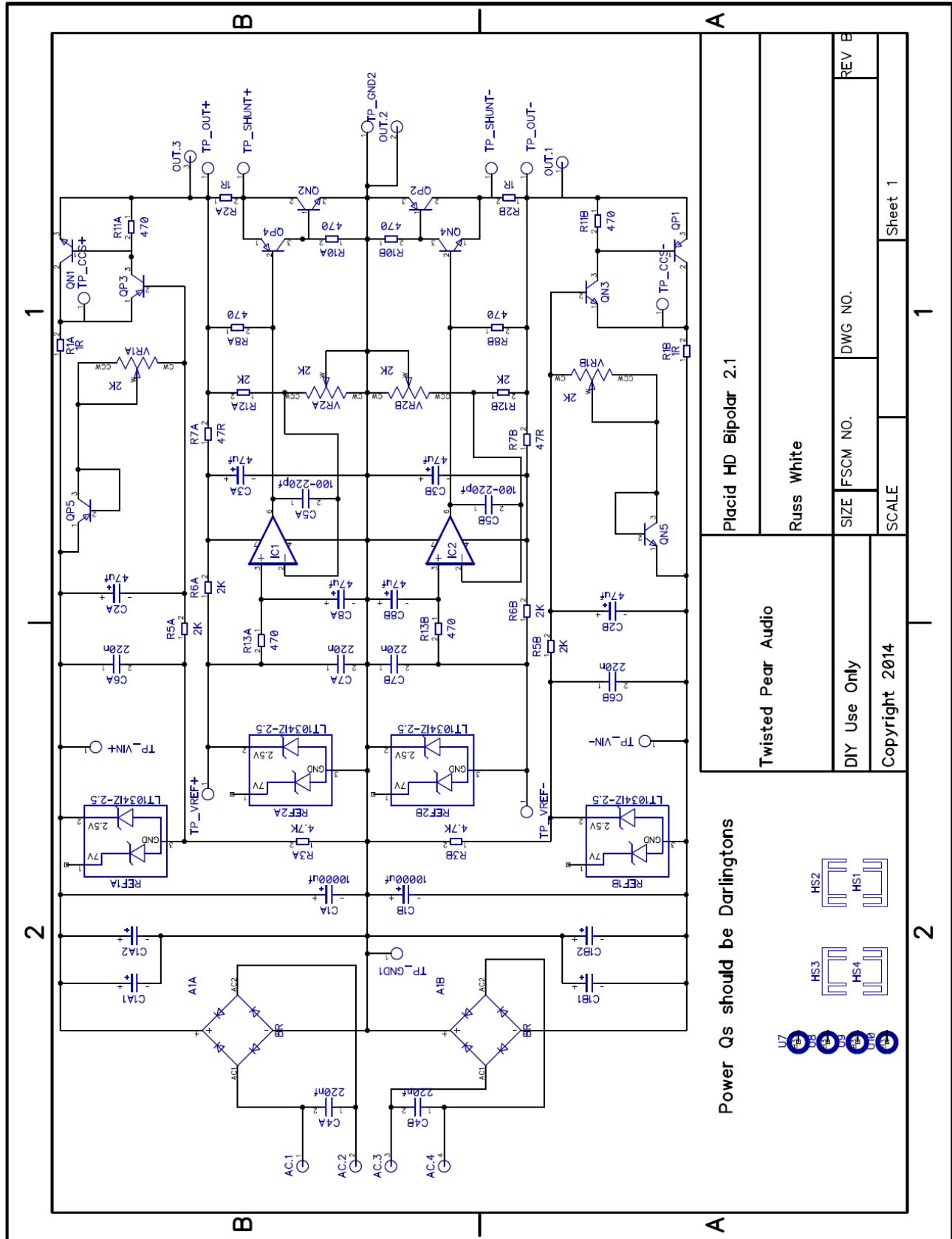
Appendix: Parts list Placid HD 2.1

RefDes	Quantity	Value	Type	Pattern	Manufacturer	Part#	Mouser SKU	Digikey SKU
C1 (A)	1	10000uf	35V Snap-in Electrolytic Capacitor	EB35D	Panasonic	ECO-S1VP103EA	667-ECO-S1VP103EA	P6914-ND
C2, C3, C8 (A)	3	47uf	50V Low-ESR Electrolytic Capacitor	E2,5-7	Panasonic	EEU-FC1H470H	667-EEU-FC1H470H	EEU-FC1H470H-ND
C4, C6, C7 (A)	3	220nf	MKS Film Capacitor	C050-055X075	Wima	MKS2-0.22/63/10	505-MKS2.22/63/10	
C5 (A)	1	100pf	FKP Film Capacitor	C050-055X075	Wima	FKP2-100/100/5	505-FKP2100/100/5	
R1, R2 (A)	2	1R	5% 1W Metal Oxide Resistor	0411/15	Panasonic	ERX-1S1R0	667-ERX-1S1R0A	P1.0W-18K-ND
R3 (A)	1	4.7K	1% .25W Metal Film Resistor	0207/10	Xicon	271-4.7K-RC	271-4.7K-RC	
R5, R6, R12 (A)	3	2K	1% .25W Metal Film Resistor	0207/10	Xicon	271-2K-RC	271-2K-RC	
R7A (A)	1	47R	1% .25W Metal Film Resistor	0207/10	Xicon	271-47-RC	271-47-RC	
R8, R10, R11, R13	4	470R	1% .25W Metal Film Resistor	0207/10	Xicon	271-470-RC	271-470-RC	
VR1, VR2 (A)	2	2K	POT	T93YA	Vishay/Sfernice	T93YA202KT20	72-T93YA-2K	T93YA-2.0K-ND
A1 (A)	1	BR	BRIDGE	KBPM	Vishay Semiconductors	2KBP01M-E4/51	625-2KBP01M-E4/51	2KBP01M-E4/51GI-ND
IC1	1	OPA209	Precision, RRO, OpAmp	SOIC-08	Texas Instruments	OPA209AID	595-OPA209AID	296-28030-5-ND
QN1, QN2	2		MJF122G	TO-220F	ON Semiconductor	MJF122G	63-MJF122G	MJF122GOS-ND
QP3-QP5	3		BC560	TO-92	Fairchild Semiconductor	BC560CTA	512-BC560CTA	BC560CTACT-ND
REF1, REF2 (A)	2	LT1034IZ-2.5	Precision Voltage Reference	TO-92	Linear Technology	LT1034IZ-2.5		LT1034IZ-2.5-ND
AC, OUT	2		2-pin	AKZ500-4	Phoenix Contact	19 35 16 1	651-1935161	277-1667-ND
HS1, HS2	2		SK104	SK104	Wakefield	637-25ABP		
Mounting Kit	1		(8) 4-40 .25" button head screws (4) .5" F-F standoffs					

Appendix: Parts list Placid HD BP 2.1

RefDes	Quantity	Value	Type	Pattern	Manufacturer	Part#	Mouser SKU	Digikey SKU
C1 (A/B)	2	10000uf	35V Snap-in Electrolytic Capacitor	EB35D	Panasonic	ECO-S1VP103EA	667-ECO-S1VP103EA	P6914-ND
C2, C3, C8 (A/B)	6	47uf	50V Low-ESR Electrolytic Capacitor	E2,5-7	Panasonic	EEU-FC1H470H	667-EEU-FC1H470H	EEU-FC1H470H-ND
C4, C6, C7 (A/B)	6	220nf	MKS Film Capacitor	C050-055X075	Wima	MKS2-0.22/63/10	505-MKS2.22/63/10	
C5 (A/B)	2	100pf	FKP Film Capacitor	C050-055X075	Wima	FKP2-100/100/5	505-FKP2100/100/5	
R1, R2 (A/B)	4	1R	5% 1W Metal Oxide Resistor	0411/15	Panasonic	ERX-1S1R0	667-ERX-1S1R0A	P1.0W-18K-ND
R3 (A/B)	2	4.7K	1% .25W Metal Film Resistor	0207/10	Xicon	271-4.7K-RC	271-4.7K-RC	
R5, R6, R12 (A/B)	6	2K	1% .25W Metal Film Resistor	0207/10	Xicon	271-2K-RC	271-2K-RC	
R7A (A/B)	2	47R	1% .25W Metal Film Resistor	0207/10	Xicon	271-47-RC	271-47-RC	
R8, R10, R11, R13	8	470R	1% .25W Metal Film Resistor	0207/10	Xicon	271-470-RC	271-470-RC	
VR1, VR2 (A/B)	4	2K	POT	T93YA	Vishay/Sfernice	T93YA202KT20	72-T93YA-2K	T93YA-2.0K-ND
A1 (A/B)	2	BR	BRIDGE	KBPM	Vishay Semiconductors	2KBP01M-E4/51	625-2KBP01M-E4/51	2KBP01M-E4/51GI-ND
IC1, IC2	2	OPA209	Precision, RRO, OpAmp	SOIC-08	Texas Instruments	OPA209AID	595-OPA209AID	296-28030-5-ND
QN1, QN2	2		MJF122G	TO-220F	ON Semiconductor	MJF122G	63-MJF122G	MJF122GOS-ND
QP3-QP5	3		BC560	TO-92	Fairchild Semiconductor	BC560CTA	512-BC560CTA	BC560CTACT-ND
QP1, QP2	2		MJF127G	TO-220F	ON Semiconductor	MJF127G	63-MJF127G	MJF127GOS-ND
QN3-QN5	3		BC550	TO-92	Fairchild Semiconductor	BC550CTA	512-BC550CTA	BC550CTACT-ND
REF1, REF2 (A/B)	4	LT1034IZ-2.5	Precision Voltage Reference	TO-92	Linear Technology	LT1034IZ-2.5		LT1034IZ-2.5-ND
AC	1		4-pin	AKZ500-4	Phoenix Contact	19 35 18 7	651-1935187	277-1579-ND
OUT	1		3-pin	AKZ500-4	Phoenix Contact	19 35 17 4	651-1935174	277-1578-ND
HS1, HS2, HS3, HS4	4		SK104	SK104	Wakefield	637-25ABP		
Mounting Kit	1		(8) 4-40 .25" button head screws (4) .5" F-F standoffs					

Appendix: Schematic Placid HD BP 2.1



Appendix: References

Reference	Link
Linear Technology LT1034 datasheet	http://cds.linear.com/docs/en/datasheet/1034fe.pdf
TI OPA209 datasheet	http://www.ti.com/lit/ds/symlink/opa209.pdf
Official and community manuals	http://www.twistedpearaudio.com/docs/docs.aspx
TPA support forums	http://www.twistedpearaudio.com/forum/default.aspx